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Aquatic plant (Aquatic Weed) potential ingredients for fish feed

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Abstract
Aquaculture and fisheries continue to be important sources of food, future earnings, nutritional security as well as economic opportunities for hundreds of millions of people worldwide. Fish as the inexpensive source of animal protein accounts for a significant portion of the worldwide food supply, as well as the global fish production sector has the challenge of increasing output to satisfy future protein demand. India has witnessed the growth of freshwater aquaculture from backyard farming to a commercial fish culture where carp remains a mainstay of Indian aquaculture contributing about 87% of the total aquaculture production of our country. In aquaculture practices feed and feeding management practices are play a vital role, about 50-60% of production cost used for feeding management. Nowadays high cost and fluctuating quality of fish meals have led to the need to discover alternative protein sources for feed formulation, considerable emphasis has been focused on the use of the conventional plant, oilseed meals, including soybean, groundnut, cottonseed, and rapeseed meals. The utilization of leaf protein concentrates as dietary feed additives have considerable promise due to the practicality of synthesizing a high-quality protein from tropical and subtropical aquatic plants leaves.

Keywords: Aquatic plant, fish, ingredient, replacement, sustainable

Introduction
Aquatic plants are vital, inexpensive, and easily available feed ingredients as well as act as a bio-fertilizer. Aquatic plants are a very good source of protein. It replaces the animal source protein in fish feed. Plants that have evolved to live in water are known as aquatic plants (saltwater or freshwater). They are almost always known as hydrophytes and macrophytes. Aquatic plants in lakes and rivers provide shelter for fish, habitat for aquatic invertebrates, produce oxygen, and serve as nourishment for several fish and wildlife. Plants are found in freshwater, brackish water, and marine water, aquatic plants are found in marine water known as seaweed and seagrass. Seagrass spends its whole life cycle underwater, with filamentous pollination that's also specifically adjusted to dispersal in an aquatic environment and ribbon-like leaflets that lack stomata. Macrophytes are aquatic plant that grows in or near water and is floating, emergent, submerged, or marginal. Floating plants freely float on the surface of water and roots hang underneath. Floating plants such as Lemma (Duckweed), Pistia (water lettuce/water cabbage), Azolla (Bio-fertilizer), Wolffia, Eichhornia water hyacinth), Spirodela and Salvinia are found in different types of water resources. Emergent plants are rooted in the bottom of the pond but their leaves float on the water surface. Emergent types of plants such as Nymphea (water lily), Nelumbo (Lotus), Nymphoides (floating heart), Myriophyllum (Watermill foil), Trapa bispinosa (water chestnut), Euryale Ferox (Fox nut). Submerged plants grow under the water surface and may or may not be rooted. 1st one is rooted in plants like Hydrilla, Najas, Vallisneria (eelgrass), Potamogeton, Ottelia, and 2nd one is rootless Ceratophyllum and Utricularia. Marginal plants grow along the shoreline of the ponds. Marginal plants are found in different types that is Sagittaria (Arrowhead), Ipomoea (morning glory), Typha (Cattail), Cyperus, Colocasia (Elephant ears), and Marsilea.
In the ecosystem, aquatic plants provide food and shelter for sea/freshwater creatures, as well as soil stability, which helps to avoid erosion of shorelines, ponds, and lakes. Aquatic plants' adaptation is visible in their structure, which includes deeply dissected and waxy leaves,

specialized pollination mechanisms, and growth pattern variation. Adaptation determines the plant types. Because cuticles inhibit water evaporation, several aquatic plants do not require or have thin cuticles. Because they do not need to retain water, macrophytes maintain their stomata open at all times. On each side of their leaves are several stomata. Aquatic plants have less rigid structures since water pressure supports them. Plants' leaves are flat on the surface because they need to float. They can float because they have air sacs. Because their roots are relatively small, water can peacefully flow into the leaves. Their roots are light and feathery since they do not need to prop up (give support) the plants. Roots are specialized to take in oxygen. Many weeds species as food for fish or encourage the growth of the phytoplankton and zooplankton, in turn encouraging fish production. Water hyacinth sometimes acts as a good dwelling place or hiding place for fish. Weeds that grow in clean bodies of water could be used as animal feed. Water hyacinth has the capability of absorbing toxic metals through untreated wastewater generated by industrial. They have been used in cottage industries to make carpets, tablecloths, netting, baskets, and other items. They have high organic matter and so it used in biogas production. Water hyacinth is also utilized to regenerate alkaline soils. Mercuric products and cadmium, lead, zinc in water were efficiently absorbed by Azolla and so it is used to remove the heavy metals. Azolla is also utilized in the generation of biogas as well as biomass. It is also used in rice fields for having nitrogen-fixing bacteria. From the flowers of the water hyacinth, a dye is extracted for ink preparation. After the decomposition of aquatic weeds, we can get good organic manure. It acts as feed for carps. This system is exploited in controlling aquatic weeds. The aesthetic value of some plants is because of their beautiful flowers such as Nymphaea as well as Nelumbo species. Fruits, seeds, rhizomes of Nelumbo have high therapeutic potential. Extracts of Nelumbo cristata is having hepatoprotective properties and prevent damage to the liver. Lemna species absorbs toxic metals like arsenic and uranium and is also used in the bio-remediation of water. Pistia stratiotes can excess nitrogen and phosphorus in the water.

Aquatic weed used as an alternative source of fish feed

Duckweed, (*Lemna polyrhiza*)

The suitability of dried duckweed, *Lemna polyrhiza* as an aquatic plant feed ingredient for *Labeo rohita* fingerlings. They concluded that duckweed-incorporated diets resulted in a little less growth of fish as compared to the control diet with a fish meal (Das and Ray, 1989) [3]. There are eight isonitrogenous (35 percent crude protein) as well as isocaloric (4.2 kcal g/1) diets available, all of which contain unprocessed and fermented duckweed (*Lemna polyrhiza*) plant leaves meal around 10%, 20%, 30%, and 40% concentrations. They isolated Bacillus sp. as from the intestine of Common carp, which has extracellular amylolytic, cellulolytic, proteolytic, and lipolytic activities, and used it to ferment leaf meal, resulting in a reduction in fiber content from 11.0 percent to 7.5 percent, as well as reductions in anti-nutritional factors tannin and phytic acid, from 1.0 percent to 0.02 percent and 1.23 percent to 0.09 percent, respectively (Bairagi *et al.,* 2004) [1]. The dietary protein source for *Cyprinus carpio* (Common carp) fry is duckweed, *Lemna minor*. Diet prepared with 32% crude protein, incorporation of dried duckweed in different treatment with various inclusion levels 5%, 10%, 15%, and 20%. After 90 days experimental period result obtained in common carp the diet consisting of up to 20% inclusion level could be used as a complete replacement for commercial feed in diet formulation of common carp fry (Yilmaz *et al.,* 2004) [19].

Water hyacinth leaf

The utilization of water hyacinth leaf meal in the diet of fish feed. 40% water hyacinth incorporated diet and showed best growth performance in all the diet combinations they have tested (Vhanalakar *et al*., 2016). The fish meal cannot be replaced, however, it can be supplemented with water hyacinth up to 40% of the ideal level to generate a cost-effective diet that promotes the growth of *Cyprinus carpio* (Mohapatra, 2015) [9]. The impact of various fermentation procedures on the nutritional quality of water hyacinth (WH) on Nile tilapia fingerlings. Fresh dry hyacinth (FH), molasses-fermented hyacinth (MF), cow rumen-fermented hyacinth (RF), and yeast-fermented hyacinth (YF) are some of the varieties of hyacinths available. Molasses-fermented performed better than yeast-fermented as well as cow rumen-fermented hyacinth. Their findings suggested that when WH is included at a 20% inclusion level in Nile tilapia diets, fermentation may not be required (El-Sayed *et al.,* 2003) [5].

Water hyacinth leaf meal

The Water hyacinth leaf protein concentrate (WHLPC) in P. monodon fed diets. Used different type inclusion levels of (WHLPC) 0%, 25%, 50%, and 75%in four different treatments respectively. Results obtained after 60 days experimental shrimp have the best growth and survival this result indicated that soybean meal dietary protein can be replaced by WHLPC till 57% without any adverse effect in *Penaeus monodon* (Chavez *et al.,* 2014) [2].

Water lettuce (*Pistia stratiotes*)

Water lettuce (*Pistia stratiotes*) is a valuable source of proteins used as fish feed ingredients in different ratios for both food and non-food uses fish. That is used for partial replacement of fishmeal with aquatic weed *Pistia stratiotes* meal on *Labeo rohita* fingerling. They did 80 days experimental period and prepared five different experimental diets with different inclusion levels 0%, 10%, 20%, 30%, 40%, 50% respectively. There is obtained maximum growth rate and better FCR in 30% inclusion level (Nisha and Geetha 2017) [12].

Hydrilla (*Hydrilla verticillata*)

Hydrilla verticillata as an alternative protein source of Tilapia sp. Prepared five experimental diets with different inclusion levels 0%, 20%, 30%, 40%, 50% respectively. Obtained 10% inclusion level of *Hydrilla verticillata* gives the best result (Dhamayanti *et al.* (2016) [4].

Aquatic fern (Azolla)

In the feed of *Labeo rohita* fry, Azolla protein Concentrate (APC) was blended with Spirogyra powder (SP) in a 4:1 ratio to replace fish meal. Incorporated APC –SP with different inclusion levels in fish feed. There are prepared five isonitrogenous and isocaloric diets by replacing fish meal with APC-SP in different treatment T1, T2, T3, T4,

and T5 with inclusion levels 0%, 25%, 50%, 75%, and 100% respectively. Results obtained after 60 days experimental period growth performance of *Labeo rohita* very good, there is no mortality, histological changes not found and didn't have any adverse effect. That APC is a rich source of protein and can be used to replace 10% of fish meal in the diet of *Labeo rohita* fry to a maximum of 16.25 percent (Sheeno and Sahu, 2006).

Table 1: Nutritional profile of different aquatic weed

Aquatic plant	Ingredients						
	Crude protein (%)	Crude fat (%)	Total ash (%)	Fiber (%)	Moisture (%)	NFE Nitrogen Free Extract (%)	Reference
Lemna minor on *Cyprinuscarpio*	18.32	2.32	28.71	-		-	Yilmaz *et al.* (2004) [19]
Pistiastratiotes on *Labeorohita*	15.96±0.13	5.10±0.29	22.2±56	11.08±33		45.66±0.19	Nisha and Geetha (2017) [12]
Eichhorniacrassipes on *Labeorohita*	13.37	1.00	1.7.00	15.00		47.63	Sangbrita And Kumar (2011)
Azollacaroliniana on *Labeorohita*	24.06	4.03	22.22	10.18		39.52	Sheeno And Sahu (2006)
Azolla meal on Nile Tilapia	24-30	3 –3.3	10.50	9.1	94	-	Ebrahim *et al*. (2007)
Hydrilla Verticillata tilapia sp.	17.82	2.92	28.82	32.12		-	Dhamayanti *et al.* (2016) [4]

Table 2: Aquatic plants as a source of fish feed ingredient for replacement of fish meal on the diet of fishes.

Type of aquatic plants	Fish species	Level of added	Performance	Reference
Water fern (*Azolla pinnata*)	Rohu *(Labeo rohita)*	50%	Increased pancreatic enzyme activity	Maity and Patra (2008) [7]
Water lettuce (*Pistia stratiotes*)	Rohu *(Labeo rohita)*	30%	Enhanced weight gain, specific growth rate, and better feed conversion	Nisha and Geetha (2017) [12]
Duckweed (*Lemna minor*)	Grass carp	40-60%	More suitable for a better growth rate of fish	Srirangam (2016) [17]
Eichhornia crassipes	Rohu *(Labeo rohita)*	20%	No differences in the growth rate of Rohu	Patel *et al*. (2016) [13]
Azolla (*Azolla Sp*.)	Shabbout fish (*Tor grypus*)	20%	Higher specific growth rate and weight gain	Gokcinar and Bekcan (2015)
Eichhornia crassipes	Mrigal (*Cirrhinus mrigala*)	40%	Better growth and survival of fish	Vhanalakar *et al.* (2008) [18]
Azolla meal	GIFT Tilapia (*Oreochromis niloticus*)	15%	Better for muscle quality and stress response	Mosha *et al*. (2020) [10]
Fermented Azolla	Tilapia	20%	Higher specific growth rate and weight gain	Hundreds *et al*. (2018)

Conclusion

Plant-based protein (leaf meals) is expensive and sustainable feed ingredients as well as don't have any adverse effect on our environment and experimental species. Plant-based proteins are easily available in enough amounts in the environment. Plant-based feed ingredients which are used for fish feed ingredients replace many animal sources of protein in fish feed. Also, act as biofertilizers, provide shelter, provide feeding and breeding ground for any aquatic organisms. Aquatic plants have aesthetic value, application for sewage treatment plants (Eichhornia, Lemna, etc.) as well as aquatic plants are used in the paper and pulp industry.

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